A Report on U.S. GPM GV Science Activities

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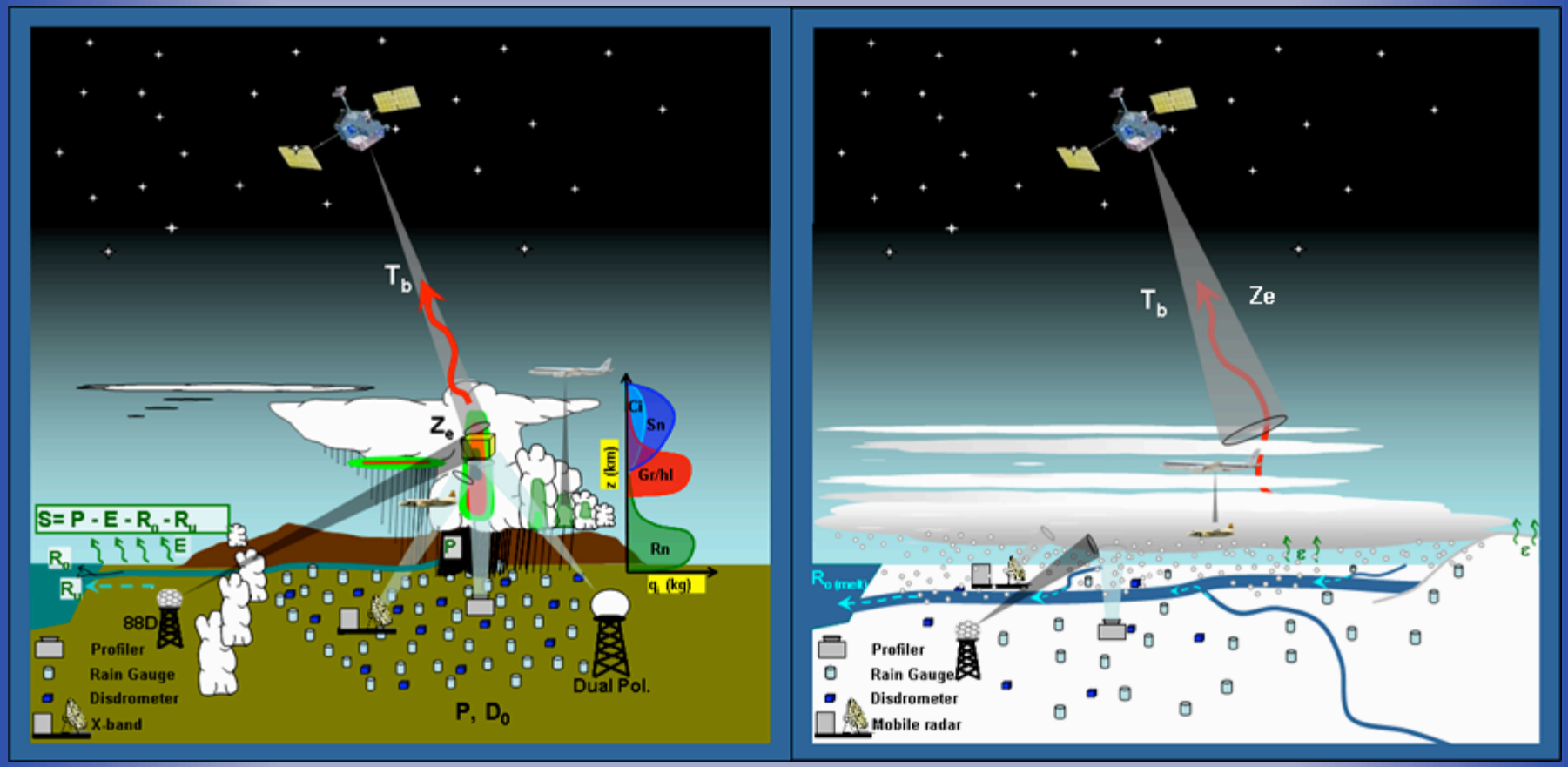
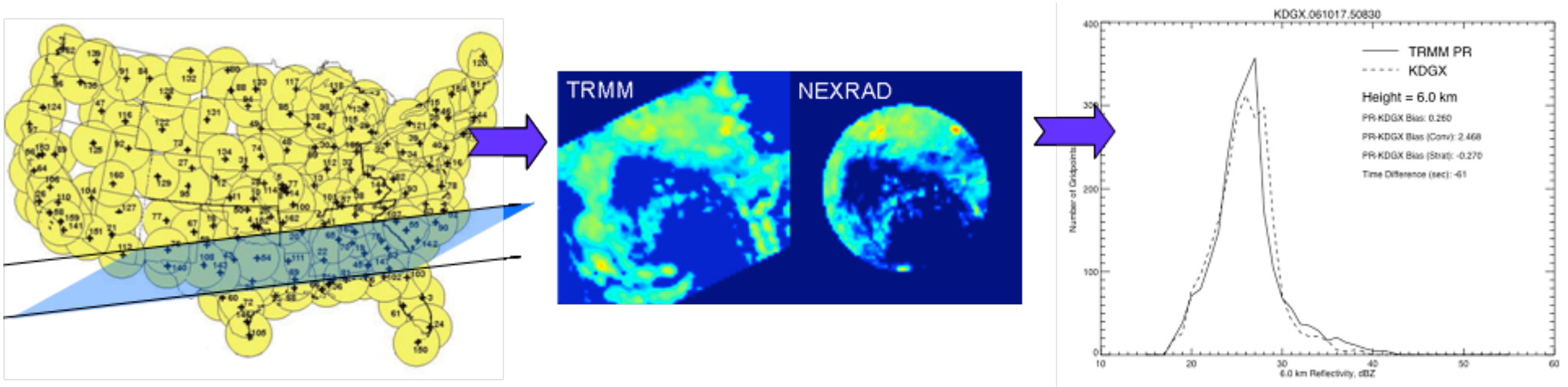


GPM Validation Network: Direct Validation of Satellite Algorithms

Identify systematic regional or regime issues: *Reflectivity*

Method 1): DPR - Ground Radar Validation Network (VN) (Morris/Schwaller et al)

- Reflectivity measurement of core satellite is *fundamental* to the entire GPM Constellation
- Regional and/or regime changes in DSD may impact PIA and Z algorithms, increasing error
- Systematic regime variability in Z_{GPM}-Z_{Ground} can be detected with existing operational radars
- Stable calibration of GPM DPR Z also supports stable calibration of ground network
- Future dual-pol radar upgrades will facilitate broad area DSD statistics (D0) to be added network ingest- subsequently permits broad scale relation of D0 variability to Z.

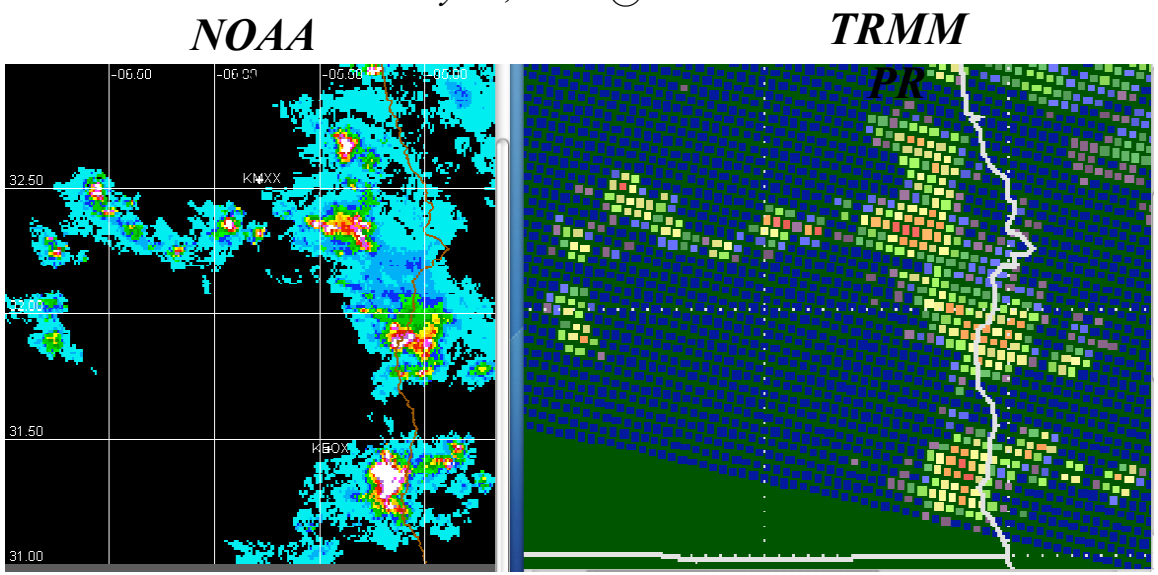


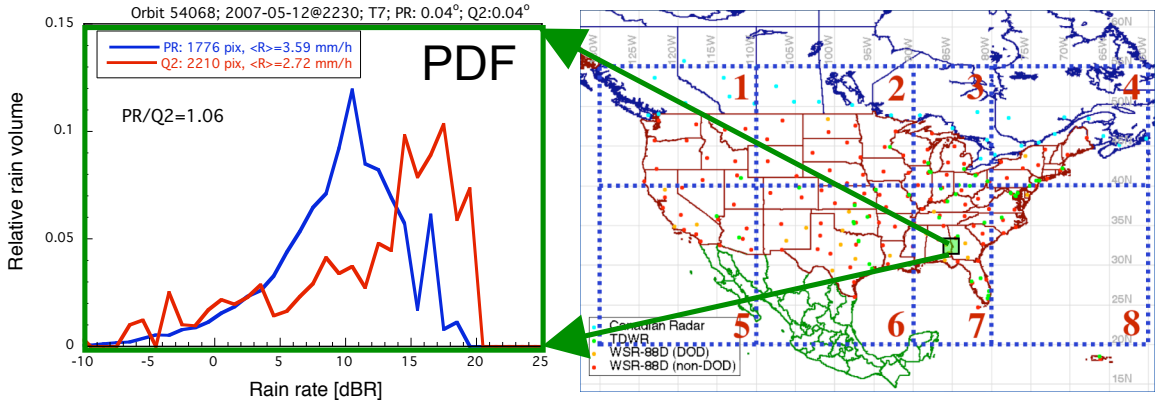
National Network: Direct Validation of Satellite Algorithms

Identify systematic regional or regime issues: *Rain Rate*

Method 2) NOAA Q2 Product (U.S. NEXRAD Network)

May 12, 2007 @ 22:30 UT





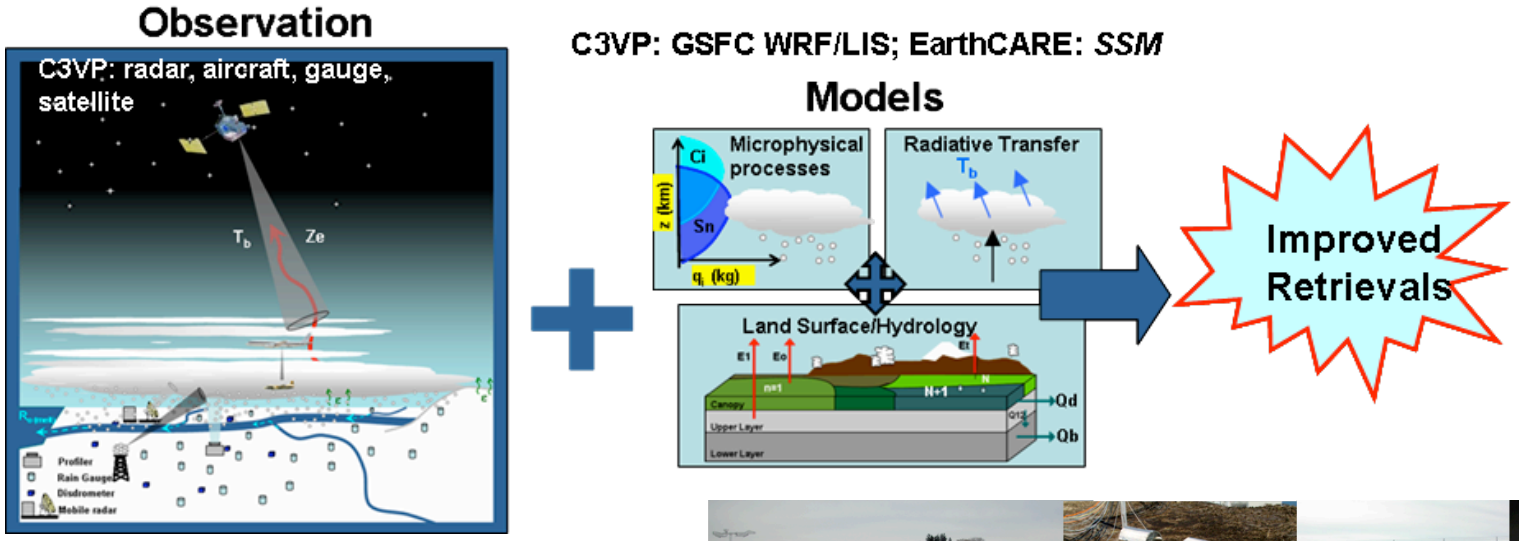
- NSSL Q2 National gridded radar/gauge product and TRMM PR near surface rain rates.
- **Current: Evaluate TRMM PR instantaneous rain rate**
- **Similar mean rain rates but different PDFs. Why?**
- **Other National Network efforts or approaches?**

Courtesy: E. Amitai et al., (George Mason University)

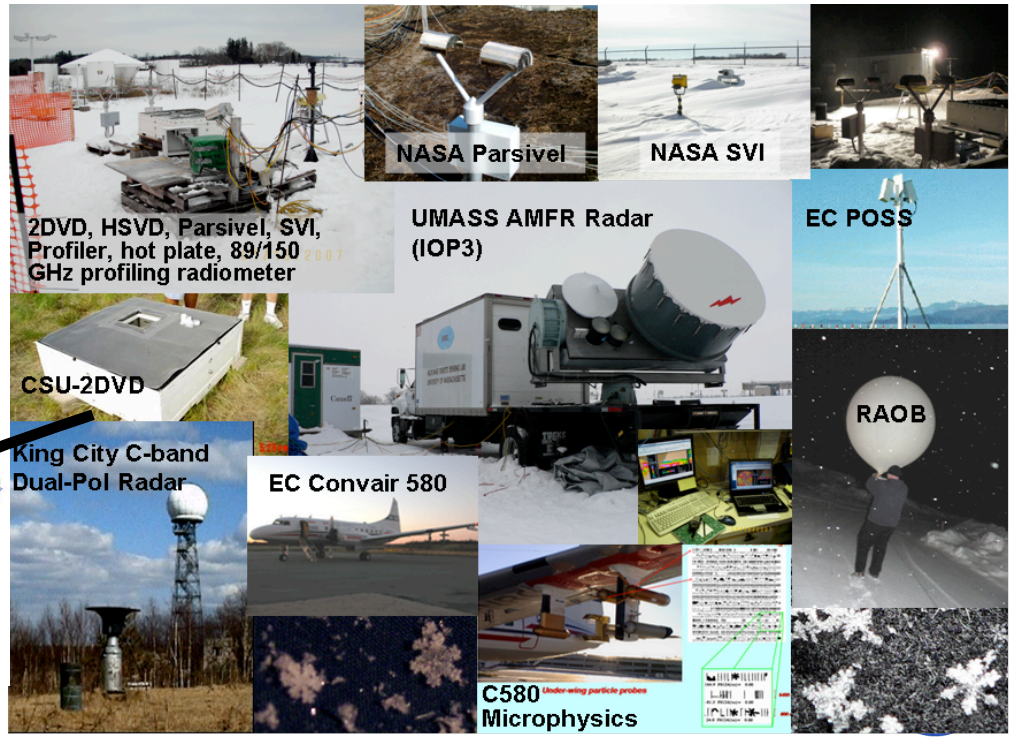
NASA Grant NNX07AK47G (2007-2010)

Physical Process Studies: Pre-Launch Field Work [Cold Season Precip]

GPM Participation in the Canadian CloudSat/Calipso Validation Project (C3VP)



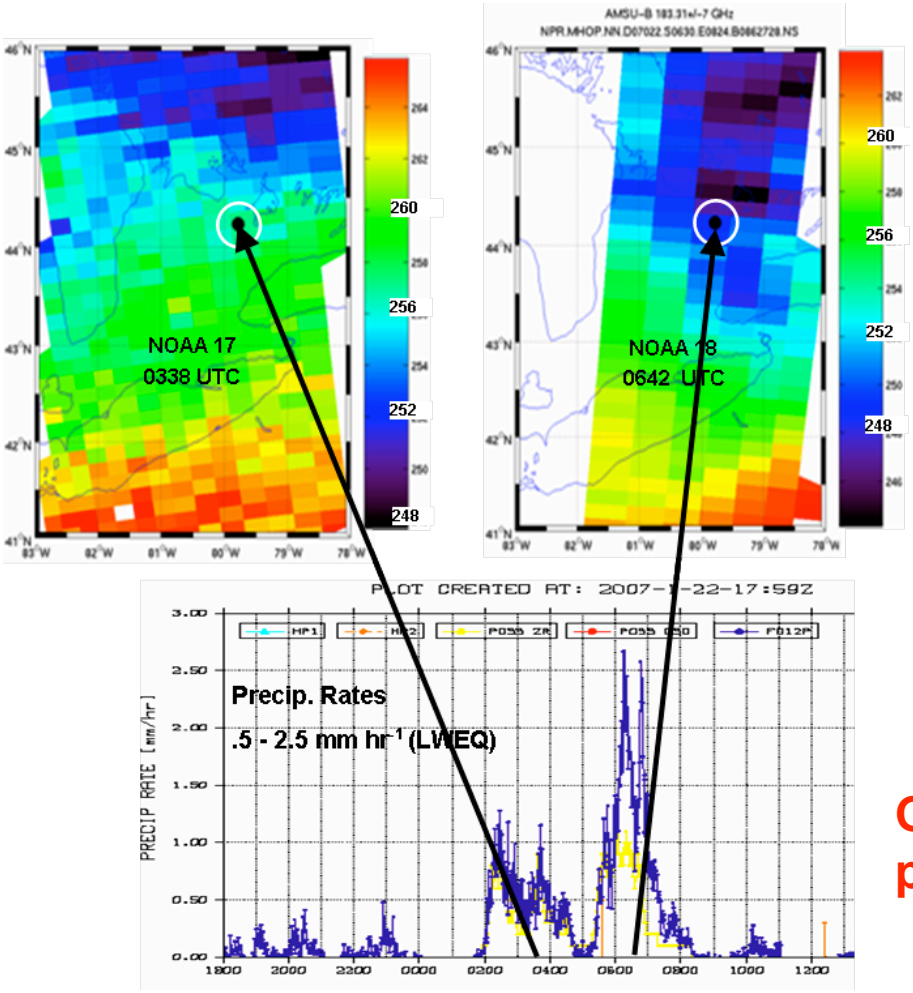
Ontario, Canada, Winter 2006-2007



Physical Process Studies: Targeting Snowfall Algorithm Issues

Priority Case: 22 January 2007 (Widespread synoptic)

Dual-pol radar, aircraft, disdrometer and gauge sampling

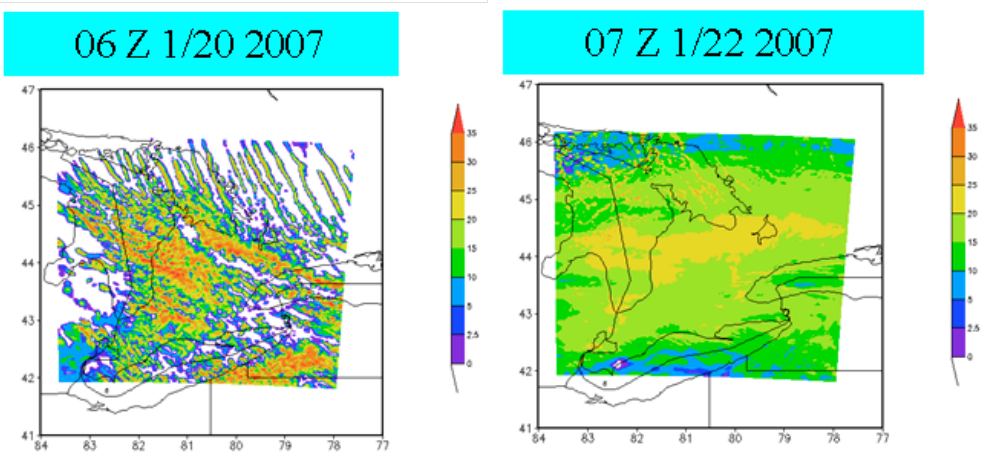


- AMSU-B 183.3 +/-7 GHz TB Decrease of only 8-10^{o} but precipitation rate increase by a factor of 2-3!
- Detectability?
- Relevant algorithm physics
  - Precipitation depth, particle habits, particle density, atmospheric water vapor, emissivity, viewing angle?

GPM Pre-launch: Quantify snow process physics and feedbacks to the algorithms

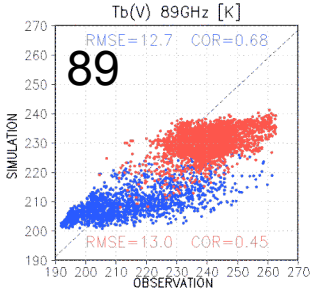
Physical Process Studies: C3VP Cloud Model Validation/Assessment

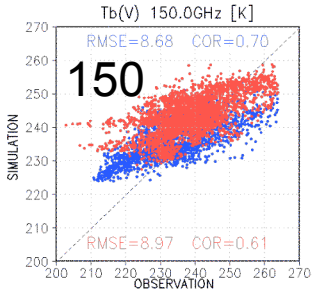
CRM/LSM cloud profile databases could support snowfall retrieval algorithms

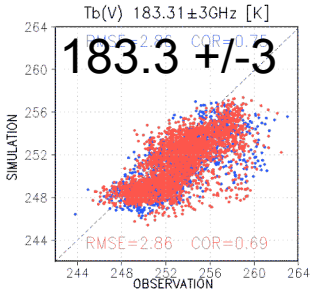


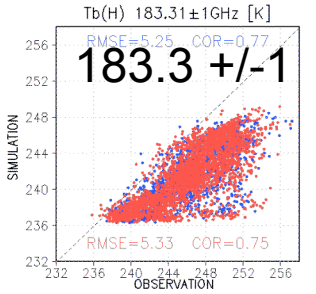
Water Points

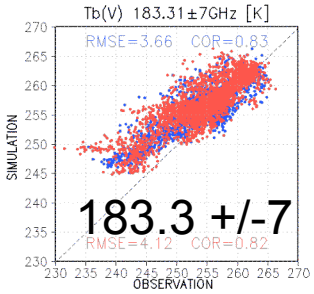
Land Points











- Model can simulate morphology well
- Simulation of 183 GHz Channels is reasonable
- But…..problems with 89/150 GHz
- What is the issue here?

CRM fidelity/utility for use in algorithm cloud profile databases must be thoroughly tested and validated

Physical Process Studies: Near Term Continental Field Campaign

Mid-Latitude Continental Clouds and Convection Experiment (MC3E; ~2010-11)

Target Location/Date: **N. Central Oklahoma, DOE-ARM Central Facility/April-June 2011**

Targeted regimes: **Transition from cool to warm-season (baroclinic, MCS, convection)**

- **GPM GV Interests and Algorithm Needs Addressed:**
  - **Process physics for GMI retrieval algorithms over land (mid-lats)**
  - **DPR retrieval algorithms (PIA, rain rate, DSD spatial/temporal covariance)**
  - **Coupled CRM/LSM for algorithm and product development**
  - **Evaluation of GV instrumentation and validation methodology**

Potential Instrument Combination (DOE and NASA Contributed):

- **Aircraft: High altitude platform (radiometer and PR2); in-situ microphysics**
- **Radars: S-band dual-pol, NASA Ka-Ku dual-pol, ARM IP-1 X-band network, ARM Ka/W-band, ARM wind profilers**
- **Surface: D-scale disdrometer and rain gauge network; soil moisture sensors, flux tower, multi-station high frequency sounding launches**

Retrievals over land a serious issue: Field campaigns planned elsewhere?

Physical Process Studies: "Core" Infrastructure Development

Measurement continuity across full spectrum of precipitation rates/types

Ka-Ku Scanning Dual-Polarimetric Radar (possibly W-band):

- Match DPR frequencies, more direct link to PIA issues.
- Bridge light precipitation measurement gap (0.2 mm/hr, GPM L2 requirement); + DSDs
- Improved sampling in snow, ice, and mixed phase
- Link clouds to precipitation
- Test dual-wavelength, dual-pol methods with the same set of data (matched)
- Mobility enables placement in any variety of network configurations with relative ease

NASA PMM N-POL S-band Scanning Dual-Polarimetric Radar

- Transportable, calibrated, platform needed for studying heavy/moderate precipitation regimes in mid-latitudes and tropics.
- Dual-pol retrieval of 3-D DSD information and qualitative ice microphysics information

Disdrometer/Gauge D-Scale Array

- Validation/extension of ground radar DSD retrievals/precipitation rates (liquid/frozen)
- Spatial/temporal covariance of particle size distributions and precipitation rates

Wind Profiler

- Vertical profiles of Z, DSD under coverage umbrella of radar

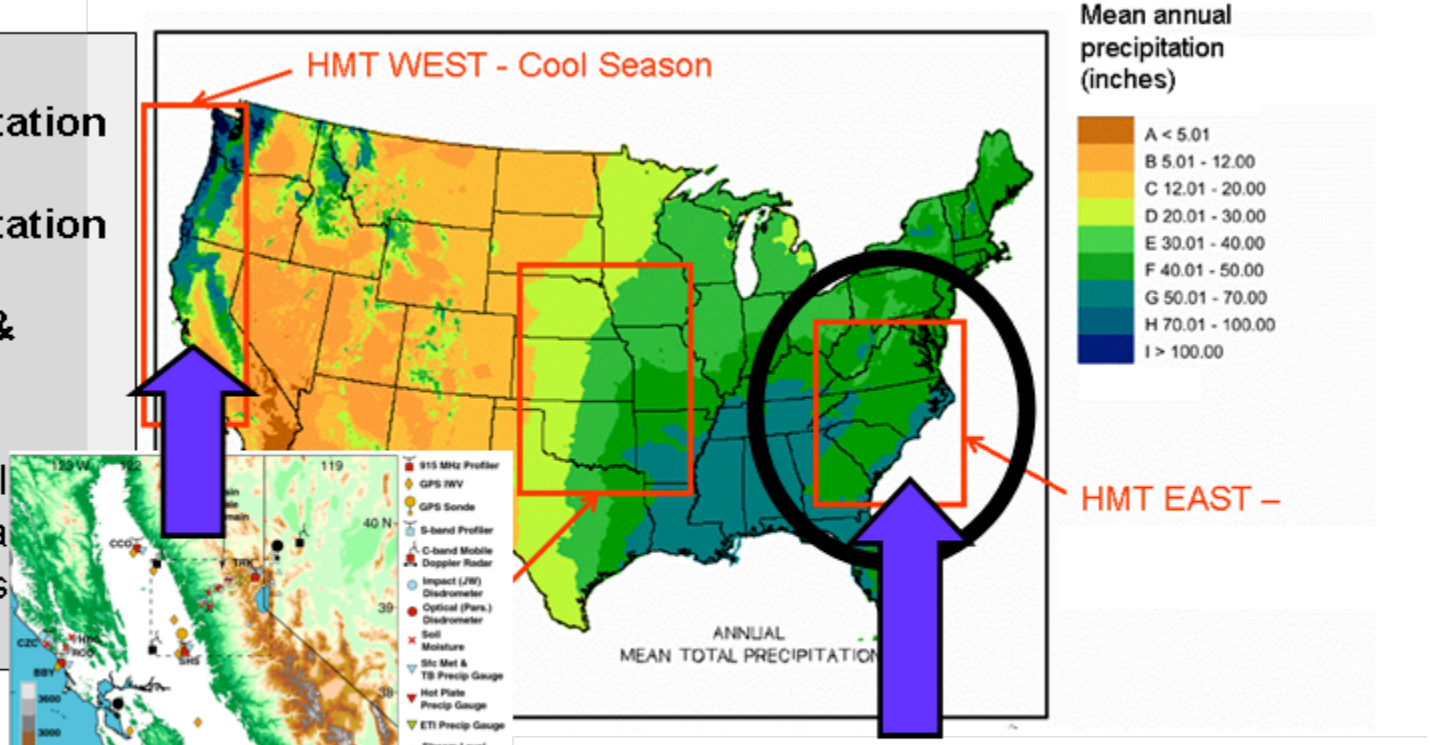
*Platforms coordinated with aircraft and other ground based measurements as needed

Integrated Validation: Collaboration with NOAA Hydrometeorology Testbed (HMT)

Testing the end-to-end utility and application of retrieval algorithms

HMT Foci

- **Quantitative Precipitation Estimates (QPE)**
- **Quantitative Precipitation Forecasts (QPF)**
- **Surface Processes & Hydrology**
- Verification
- Decision Support Tool
- Enhancing & Accelera
- Research to Operations
- Building partnerships



HMT West

IOPs 2006-07, 2007-08

LSM/CRM, downscaling, satellite precip utility?

HMT East Initial activity in 2009

Intensive field effort ~2012?

Location still TBD

Pre-launch algorithm physics linked to evaluation of hydrologic/water budget application, and hydrologic GV methods: Other opportunities?

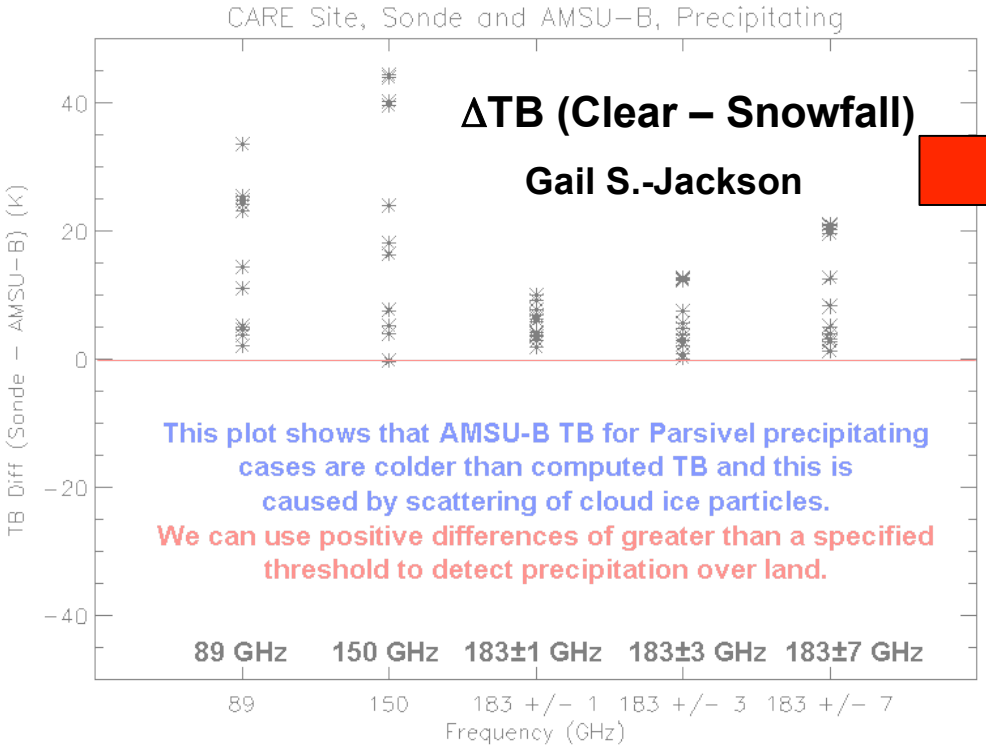
EXTRA's

C3VP RESULT: Impact on cold season retrieval algorithm development

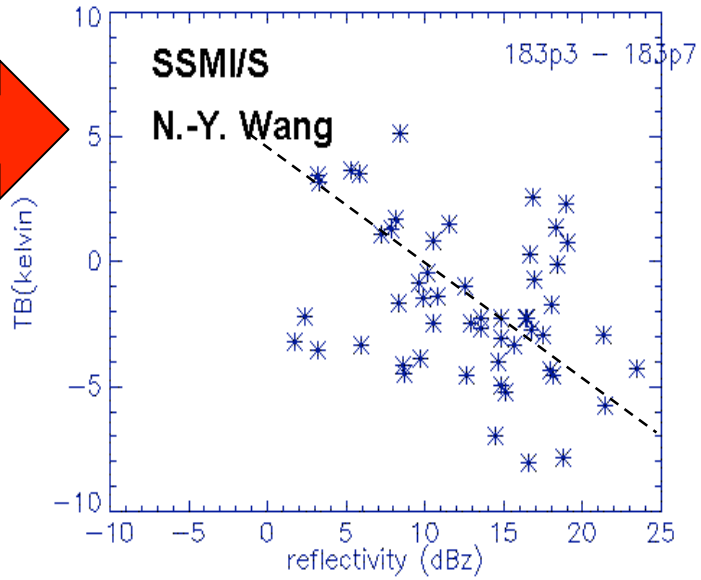
Preliminary observational result:

Use disdrometer-inferred snowfall rates, **emissivity** climatology, **surface snow depth**, King City radar data (3-D echo, snowfall) with AMSU-B and SSMI/S data to examine detection thresholds and potential for retrieving snowfall rate.

Microwave Detection: Promising!



Rate estimate: Promising!

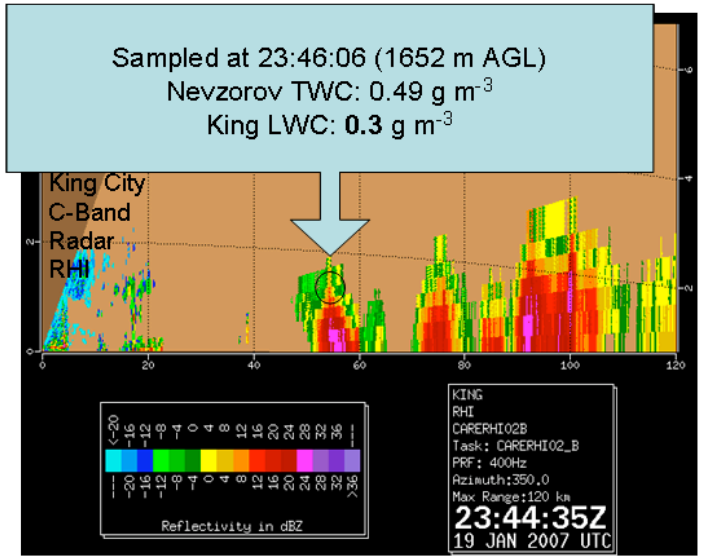


Filter water vapor contribution by channel differencing and compare to surface radar

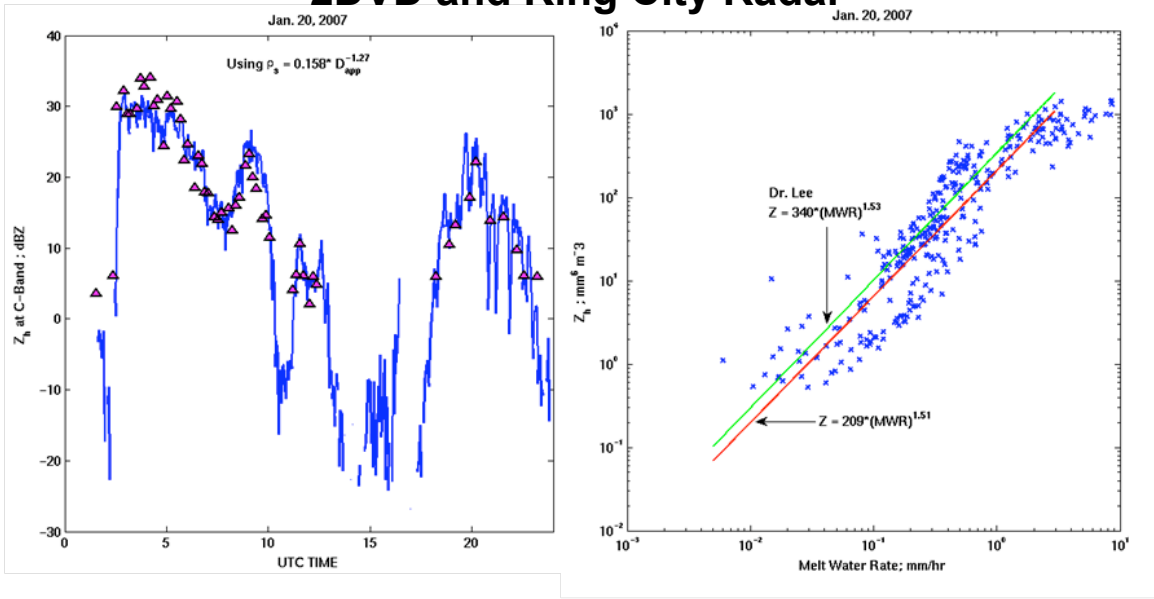
- **Refinements with analysis of airborne microphysics, dual-pol radar data, ground emissivity datasets**
- **GSFC WRF-CRM and RT simulations of priority cases for profile development**

Physical Process Studies

Priority Case 2: 20 January 2007 (Lake Effect Snowbands)



2DVD and King City Radar



Shallow bands, high Z, heavy snow, aircraft LWC of 0.3-0.4 g m^{-3}! Present challenge to satellite retrieval.

2DVD retrievals of Z (left; blue) compared to King City Radar (triangles). Excellent match. Diagnosis of water equivalent used to create Z-M in snow. (right).

Instrument "Chain"

CSU 2D Video Disdrometer + EC King City Dual-Pol Radar (Bringi and Cifelli)

- Redundant check of radar calibration
- Improved snow Z-M creation by combining measurements
- **Development of extended "area" snowfall product useful for regional scale retrieval algorithm development/testing**